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FRAUNHOFER INSTITUTE FOR ELECTRON BEAM AND PLASMA TECHNOLOGY FEP

Vacuum TechExpo

SPECIAL SEMINAR

APPLICATION-DRIVEN PRODUCTIVE VACUUM TECHNOLOGY

APRIL 15, 2014
SOKOLNIKI ECC | MOSCOW, RUSSIA

PROGRAM

TUESDAY, APRIL 15TH	
10:15 – 10:20	**Opening** W. SCHÖNBERGER *Fraunhofer-Institut für Elektronenstrahl- und Plasmatechnik FEP*
	SESSION 1 I STATE OF THE ART AND BEYOND
10:20 – 10:40	**Precision coatings for optic, electronic and sensor applications at industrial scale** W. SCHÖNBERGER, H. BARTZSCH, P. FRACH, D. GLÖSS *Fraunhofer-Institut für Elektronenstrahl- und Plasmatechnik FEP*
10:40 – 11:00	**Capacitively balanced large volume inductive plasma sources for high-rate applications** G. K. VINOGRADOV *ESTO JSC*
11:00 – 11:30	**OPENING EXHIBITION I COFFEE BREAK**
11:30 – 12:00	**Vacuum coating solutions for up-to-date industry. R&D, implementation, experience** A. KABANOV[1], J. KRISCHER[2], S. STILLE[2], V. ANISIMOV[3] *[1] Buhler AG* *[2] Leybold Optics* *[3] OAO »NII EKRAN«*
12:00 – 12:30	**LUNCH**
	SESSION 2 I DECORATIVE COATINGS
12:30 – 12:50	**Decorative colored coatings on metal strips** CHR. METZNER, H. MORGNER, B. SCHEFFEL, H. KLOSTERMANN, F. FIETZKE *Fraunhofer-Institut für Elektronenstrahl- und Plasmatechnik FEP*
12:50 – 13:10	**Industrial Scale R2R Vacuum Coatings of Metal Strip - Technology and Application** D. BRÄUNLICH, J. STRÜMPFEL, H. PRÖHL *VON ARDENNE GmbH*
13:10 – 13:30	**COFFEE BREAK**

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TUESDAY, APRIL 15TH	
	SESSION 3 I CdTe SOLAR CELLS
13:30 – 13:50	**100 MW production of CdTe solar modules by the Close Spaced Sublimation (CSS) process** B. SIEPCHEN *CTF-Solar GmbH*
13:50 – 14:10	**Technology chain for CdTe thin-film solar cells** E. SCHWUCHOW, H. MORGNER, O. ZYWITZKI, CHR. METZNER *Fraunhofer-Institut für Elektronenstrahl- und Plasmatechnik FEP*
14:10 – 14:30	**Q & A SESSION I CLOSING** W. SCHÖNBERGER *Fraunhofer-Institut für Elektronenstrahl- und Plasmatechnik FEP*
14:30	**END**

ABSTRACTS

Precision coatings for optic, electronic and sensor applications at industrial scale

W. SCHÖNBERGER, H. BARTZSCH, P. FRACH, D. GLÖSS
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Deposited as layers, precision coatings need to fulfill several properties with a very close tolerance range. These could be, for example, conductivity or insulation properties, film stress and refractive index, structural properties such as crystal phases, roughness and barrier properties. It is often a big challenge to demonstrate the feasibility of a layer that meets such a requirement matrix on a laboratory scale. This challenge increases significantly when a coating process is transferred into production line on large-area substrates. Productivity and high reproducibility of the coating process on a large area, in addition to meeting the required properties (e.g. < ± 0.5% layer thickness variation) should be guaranteed. Precision coatings are widely used in the optical industry to prepare e.g., optical filters, mirrors and antireflection coatings. Other applications include nanotechnology, sensor technology (e.g. the piezoelectric and insulation layers), electronics (SAW and BAW elements) and MEMS. The magnetron sputtering in this case represents the process that can meet strict requirements to the layer deposition technology with sufficient productivity.

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ABSTRACTS

Capacitively balanced large volume inductive plasma sources for high-rate applications

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Industrial vacuum applications such as surface modification, etching and deposition rely heavily on the plasma generators supplying activated species to the reaction surfaces. There are basically two kinds of electrical discharges mainly used in vacuum equipment: capacitively and inductively coupled plasma sources, CCP and ICP, respectively.
CCP technology is usually used for ion treatment and sputtering, PECVD (Plasma Enhanced Chemical Vapor Deposition) and narrow-gap dielectric etching, while the ICP discharges are used as high plasma density downstream sources of free radicals and a low-potential plasma for high rate etching processes like photoresist and silicon etching (including Bosch process), surface activation in PEALD (Plasma Enhanced Atomic Layer Deposition), silicon oxidation and nitridation etc.

ESTO JSC has started development and manufacturing of large volume ICP sources based on the capacitively balanced inductive technology also known as Lambda- and Gamma-Resonators collectively referred to as Transmission Line Plasma Sources. Such plasma systems made in Japan known as Lambda Ashers are widely accepted for both front- and back-end lines in 300 mm semiconductor mass-production fabs worldwide.

These plasma sources are intended for high rate surface cleaning of various materials, dry etching and deposition, synthesis and processing of powder materials and nano-particles and for plasma stimulated growth of nanotubes.

Basic principles, technical merits and first design rules of the transmission-line balanced inductive plasma sources will be reviewed.

ABSTRACTS

Vacuum coating solutions for up-to-date industry. R&D, implementation, experience

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Since many decades Leybold Optics – worldwide leader in adding value thin film coating technology – is providing state-of-the-art industrial solutions for precision optics and ophthalmics, packaging and capacitor films, TV-screens and monitors, car-industry and production of the multi-functional glass.
Such innovative products as transparent packaging films with high barrier properties, anti-scratch and hydrophobic touch screens, effective reflectors, protective glass with enhanced transmission and save-energy coatings for architectural purposes - are already part of our everyday life. Time of flexible monitors, plastic newspapers, clever clothes and other actually exotic products is knocking the door. Very soon the industry will need according proven solutions, and Leybold Optics is stating: »We are on it, and will provide you with suitable technology«.

Being since 1,5 years part of Swiss corporation Bühler AG, Leybold Optics is strengthening its position on different markets all over the world. Our company is permanently working on the state-of-the-art technologies and products, which increase efficiency of our everyday life. To stay on the high technological level and at the same time to keep in touch with reality, we cooperate with R&D institutes and commercial organizations all over the world. Representatives of Leybold Optics will introduce here their latest achievements in magnetron coating systems for precision optics and architectural glass. Our Russian customer R&D company »NII Ekran« will report its experience with electron beam gun batch coating system SYRUSpro710 for Precision Optics; describe process capabilities of the machine and report valuable results of its running within last 3 years.

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ABSTRACTS

Decorative colored coatings on metal strips

C. METZNER, H. MORGNER, B. SCHEFFEL, H. KLOSTERMANN, F. FIETZKE
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A great variety of coating materials can be obtained by methods of physical vapor deposition (PVD). Nearly all inorganic coating materials composed of metals, alloys and compounds can be realized. For instance high-quality oxide or nitride coatings can be produced by pulsed magnetron sputtering or by plasma-activated electron beam evaporation. This overview gives an introduction to the latest developments in relevant PVD technologies and presents some results for decorative purposes on metal strips. Interesting decorative effects were obtained by »Surface colored coatings« like nitride or carbide layers. Such compounds have a high hardness and a characteristic color. Gold-colored and well-adherent titanium nitride coatings with a micro-hardness up to 30 GPa could be deposited onto stainless steel strip by plasma-activated electron beam evaporation. Zirconium - Aluminum nitride layers were deposited by pulsed magnetron sputtering. The color of the layers can be adjusted by the composition of the compound in a wide range.

»Interference colored coatings« can be made by thin transparent, mostly oxide layers like Silica, Zirconia or Titanium oxide. The color of the coatings can be adjusted by the layer thickness in a wide range. Pulsed magnetron sputtering is the most common deposition process. Nevertheless Titanium dioxide thin films were deposited on stainless steel strips by high-rate plasma-activated electron beam evaporation. The process is based on generation of titanium vapor and chemical reaction in a pure low-pressure oxygen atmosphere. Crystalline titanium dioxide thin films, especially layers with predominantly anatase phase, exhibit super-hydrophilic and photo-catalytic activities after exposition to ultraviolet light. Refractive index of titanium dioxide coatings was measured in the range of 2.3 to 2.5. This relatively high refractive index causes strong color effects based on thin film interference.

It could be shown that scratch resistance of steel surface was remarkably increased by deposition of thin fused quartz layers. These transparent coatings were prepared by evaporation of silicon dioxide.

ABSTRACTS

Industrial Scale R2R Vacuum Coatings of Metal Strip - Technology and Application

D. BRÄUNLICH, J. STRÜMPFEL, H. PRÖHL
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VON ARDENNE is located in the center of vacuum technology in Dresden, Germany, and is a worldwide leading manufacturer of equipment for nanometer to micrometer thin coatings of metals, oxides, alloys or ceramics on materials such as glass, metal strip, metal tubes, wafers or polymer webs.

Several decades of experience in vacuum coating technology and the focus on research and development make VON ARDENNE a supplier that can provide to customers distinct competitive advantages in large surface area coating considering energy savings and energy generation. VON ARDENNE's metal strip coating systems are modular-designed, flexible production platforms for thin-film coatings on metal strip based on physical vapor deposition (PVD). Air-to-air systems allow continuous strip processing with external coiler and handling. Batch systems are available, as well. Complex and highly functional layer stacks can be created by depositing multiple layers of metals and oxides while using different PVD processes.

Metal strips with decorative coatings provide a high-value surface with minimal usage of expensive materials. The variety of the decorative usage is endless for in- and outdoor applications. Metal strips with increased reflectivity for the lighting industry significantly save energy while keeping the same lighting intensity. Highly reflective mirrors on metal strips are used to concentrate sunlight in Concentrated Solar Power (CSP) plants. The collected heat is used to generate power or steam for industrial applications. Metal strips with an absorber coating are used in flat and pressurized tube collectors. As a centerpiece of the solar thermal collector, they absorb sunlight with high efficiency and heat up a fluid, usually water. Main applications are space heating and domestic hot water or cooling if used in connection with an adsorption chiller. Corrosion protection layers on metal strips are used in the automotive industry or in consumer products to gain the lifetime of those products. VON ARDENNE has gained unique expertise by developing and realizing numerous industry-proven metal strip coating systems. The customers benefit from integrated technological support and our full service portfolio once the system is installed and operating.

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ABSTRACTS

100 MW production of CdTe solar modules by the Close Spaced Sublimation (CSS) process

B. SIEPCHEN
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Large scale production of solar modules in the Gigawatt range is already today a prerequisite to survive in a highly competitive market. The technologies involved need to enable high solar cell efficiency, low cost of ownership, high grade of automation and inline production with high throughput.

Production of CdTe solar modules has shown to meet those requirements. The properties of the absorber material CdTe allow to process polycrystalline films with a thickness below 5 µm. Solar cell efficiencies above 19% have been published recently.

CTF Solar GmbH is offering production solutions with nominal line capacity between 80 to 300 MW which are easy to start with low CAPEX, but highly scalable to quickly bring customers to a large scale output. The overall production cost of our technology below 40€ct/Wp can be reached. The processes involve the coating of 120×160 cm² transparent conductive oxide glass (TCO) substrates using thin film techniques. Initially a CdS and CdTe layer are deposited in vacuum by the Close Spaced Sublimation (CSS) process. CSS is characterized by a high raw material utilization and deposition rate. High quality absorber layers can be processed in less than one minute. In the next step the CdTe layer is wet chemically treated by activation and etching treatments. The technology offered by CTF for the back contact provides a good stability and ohmic connection to CdTe. Sb_2Te_3 together with metal layers are deposited using sputtering process. The series interconnection in thin film solar modules is directly integrated into the layers using laser scribing technique.

Research and development is done by CTF Solar on cell and module scale focusing all processes involved to reach higher efficiencies and to lower the production costs. In the presentation we will report about the technology, possibilities and research activities.

ABSTRACTS

Technology chain for CdTe thin-film solar cells

E. SCHWUCHOW, H. MORGNER, O. ZYWITZKI, C. METZNER
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Cadmium telluride-based thin-film solar cells hold 8% market share of all installed photovoltaics (PV). This makes CdTe the most successful thin-film PV technology currently available on the market. The underlying process technologies combine high production efficiency with low production costs which are excellent prerequisites to gain competitiveness in the embattled PV sector.

The complete process chain for the R&D/pilot production of CdTe cells is available at Fraunhofer FEP. This process comprises the deposition of transparent conducting oxides (TCOs), the thermal evaporation of the Cadmium sulfide window-layer and the deposition of the following CdTe absorber-layer using the CSS (close-spaced sublimation) working principle, the chlorine activation and the tellurium enrichment after the deposition of the absorber layers (both with different process options) and, finally, the deposition of the metal back contact (gold, nickel, molybdenum).

Beside the manufacturing technologies, the analytical characterization of produced samples is of great importance. As demonstrated at several conferences, the analytical department of the FEP is able to produce high resolution SEM- and AFM-mappings, ion-polished cross-sections, to create indepth composition profiles with RF-GDOES and EDX as well as to conduct electrical characterizations with EBIC-, IV- and EQE-measurements to obtain a detailed analysis of the deposited systems.

The technological capabilities available at the Fraunhofer FEP in the field of CdTe research will be presented within the talk.

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BÜHLER

Buhler is the global specialist and technology partner in the supply of plants, equipment and services for processing grain and food as well as for manufacturing high-grade materials. The company holds leading market positions as a provider of flour production and feed manufacturing installations as well as aluminium die casting systems and vacuum coating solutions. Buhler is active in over 140 countries and has more than 10,000 employees worldwide. Its global service organization with a staff of 1,500 supports customers anywhere, at any time, and throughout the life cycle of their plants.

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CTF SOLAR
CNBM

CTF is the first and only company worldwide to offer equipment and solutions for the production of Thin Film PV modules based on the reliable cadmium telluride (CdTe) technology – which was originally developed by today's CTF scientists and engineers. We provide our customers with almost 30 years of relevant experience. Our factory services cover all stages from initial technical concept studies and economic evaluation up to erection of the factory, manufacturing process implementation and production ramp up.
Secondly, CTF SOLAR offers Engineering-Procurement-Construction service (EPC) for solar power plants. Our solar plant services comprise all EPC and financing activities and range from initial project development up to turnkey handover of the plant to the customer.

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Fraunhofer FEP

Fraunhofer FEP is an institute of Europe's largest application-oriented research organization, the Fraunhofer-Gesellschaft. For more than 20 years we gathered expertise in vacuum coating technologies, electron beam surface modification processes and electron beam source development.

Vacuum roll-to-roll technologies, plasma activated high-rate deposition, pulse magnetron sputtering, high-rate plasma enhanced CVD and the development and application of electron beam sources are our specialities.

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ESTO Group is a union of Russian companies specializing in development, manufacturing, modernization, selling and maintenance of special technological equipment.

Members of ESTO Group are »Electronservice« JSC, »Laser&Apparatus TM« LLC, »ESTO-Integration« JSC and »ESTO-Vacuum« JSC.
ESTO-Vacuum focuses on the development and manufacturing of automatic vacuum systems for magnetron, thermal and ion-beam evaporation, plasma etching and plasma-assisted sedimentation.

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Leybold Optics (a part of Buhler) - is worldwide leader in applying of the vacuum coating technology to different industrial purposes, pioneer in engineering of the efficient solutions for deposition of adding value thin film functional coatings. Leybold Optics is offering solutions for coating of solid and flexible substrates, made of glass, plastic, metal, film and other materials. The bundling of the competencies of Bühler and Leybold Optics creates even larger pool of expertise and experience that can be utilized for developing innovative customer solutions.

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ОАО "НИИ "ЭКРАН"

Russian company, founded in 1949, is specialized in creation of aviation electronic equipment, electronic and optical-electronic protection systems for aircraft and helicopters. Advances in this field have allowed the company to reach a new level of development. Production facilities of NII EKRAN are using state-of-the-art process and test equipment, which allow to keep the highest quality and step by step go further on with R&D activities. Recently our company stepped in production of navigation systems for air- and water-transport.

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VON ARDENNE

VON ARDENNE is a worldwide leading manufacturer of equipment for industrial vacuum processes of plasma and electron beam technologies. We develop and manufacture systems for the micro- and nanometer-thin coating of glass, metal strip or web.
Our customers use them to manufacture for instance architectural glass, solar modules, solar absorbers and reflectors. All coating processes performed with VON ARDENNE equipment have one thing in common: The finished products save or produce energy.

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LOCATION

The Sokolniki Exhibition and Convention Centre is located in the like-named park, just a 5 minute walk from Sokolniki subway. The way from the park entrance to pavilions of the Sokolniki Exhibition and Convention Centre takes about 15 minutes, during which you can actually enjoy the beautiful views of the park.
Entrance to park is free.

Free Shuttle
Use a free shuttle during any exhibition period. The bus runs from Sokolniki subway to the Sokolniki Exhibition and Convention Centre. Follow the arrows at subway and in front of exhibition pavilions 2 and 4.

By Car
If you're driving a car, follow the 3rd Luchevoy prosek to get inside the park. Entry fee is 100 rubles. The car can be parked in designated parking lots.

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The special seminar »Application-Driven Productive Vacuum Technology« is organized by the Fraunhofer Institute for Electron Beam and Plasma Technology FEP in Dresden, Germany.

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